

**OFFICE OF COMMERCIAL PROGRAMS' RESEARCH ACTIVITIES  
FOR SPACE STATION FREEDOM UTILIZATION**

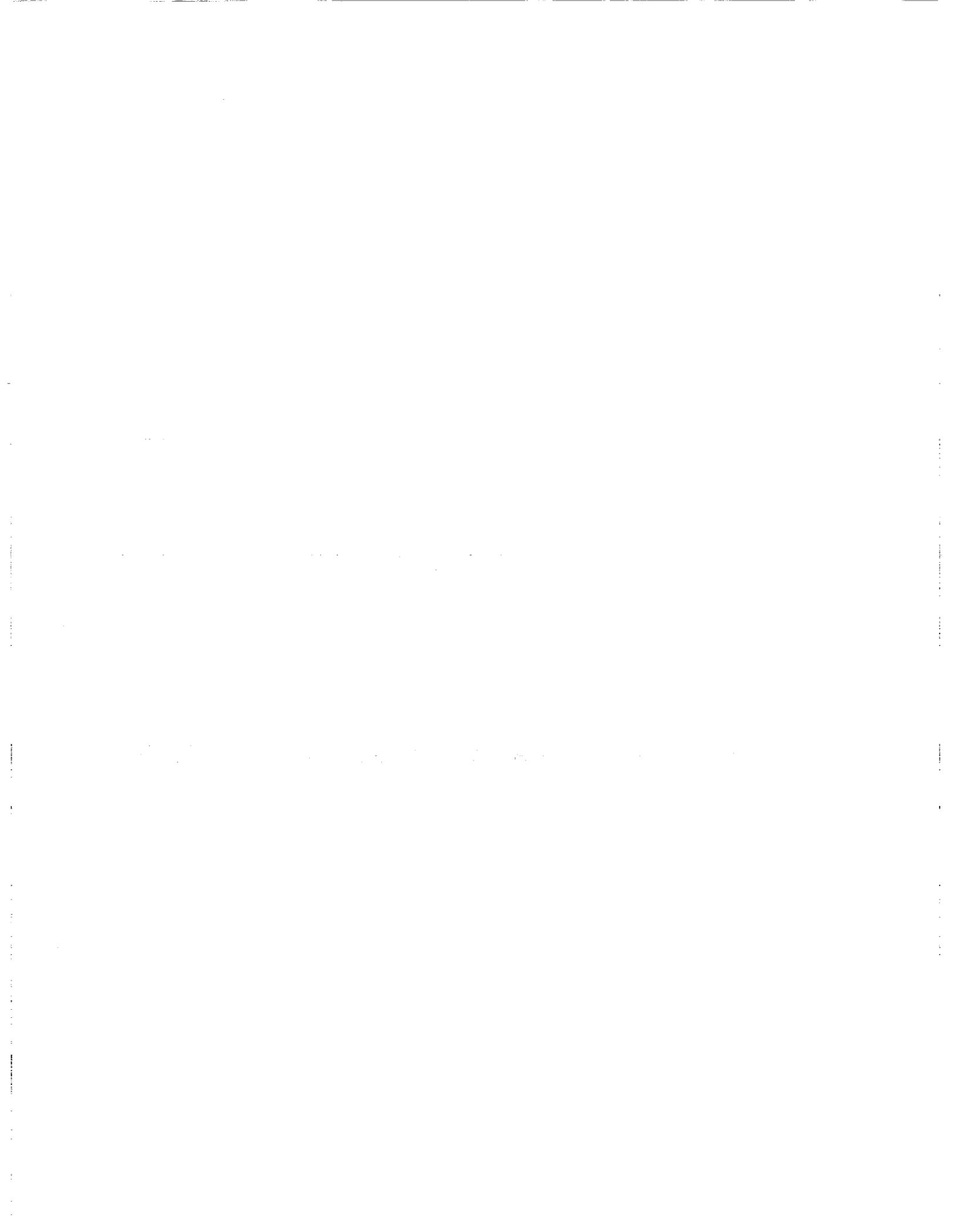
Presented by James A. Fountain  
Office of Commercial Programs  
NASA Headquarters

**ABSTRACT**

One of the Objectives of the Office of Commercial Programs (OCP) is to encourage, enable, and help implement space research which meets the needs of the U.S. industrial sector. This is done mainly through seventeen Centers for the Commercial Development of Space (CCDSs) which are located throughout the United States. The CCDSs are composed of members from U.S. companies, universities, and other government agencies. These Centers are presently engaged in industrial research in space using a variety of carriers to reach low Earth orbit. One of the goals is to produce a body of experience and knowledge that will allow U.S. industrial entities to make informed decisions regarding their participation in commercial space endeavors. A total of 32 items of payload hardware have been built to date. These payloads have flown in space a total of 73 times.

The carriers range from the KC-135 parabolic aircraft and expendable launch vehicles to the Space Shuttle. This range of carriers allows the experimenter to evolve payloads in complexity and cost by progressively extending the time in microgravity. They can start with a few seconds in the parabolic aircraft and go to several minutes on the rocket flights, before they progress to the complexities of manned flight on the Shuttle. Next year, two new capabilities will become available: COMET, an expendable-vehicle-launched experiment capsule that can carry experiments aloft for thirty days; and SPACEHAB, a new Shuttle borne module which will greatly add to the capability to accommodate small payloads.

All of these commercial research activities and carrier capabilities are preparing the Office of Commercial Programs to evolve those experiments that prove successful to Space Station Freedom. OCP and the CCDSs are actively involved in Space Station design and utilization planning and have proposed a set of experiments to be launched in 1996 and 1997. These experiments are to be conducted both internal and external to Space Station Freedom and will investigate industrial research topics which range from biotechnology to electronic materials to metallurgy. Some will be designed to make maximum use of the quiescent microgravity conditions in the "ground-tended" phases during the early years of Space Station Freedom operations.



**NASA OFFICE OF COMMERCIAL PROGRAMS'  
RESEARCH ACTIVITIES FOR SPACE STATION FREEDOM**

Presented at the

**Space Station Freedom Utilization Conference**

**Session 3: Discipline Perspectives: Microgravity Research  
and Biotechnology**

**Von Braun Civic Center  
Huntsville, AL**

By

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for the  
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Washington, DC**

**August 5, 1992**



**OFFICE OF  
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PROGRAMS**



**SPACE  
STATION  
FREEDOM**

**SPACE STATION FREEDOM PAYLOAD SPONSORS**

- **JAPAN - NASDA**
- **EUROPEAN SPACE AGENCY - ESA**
- **CANADA - CSA**
- **UNITED STATES - NASA**
  - Office of Commercial Programs - OCP (Code C) - 28%
  - **Office of Space Science and Applications - OSSA (Code S) - 52%**
  - **Office of Aeronautics and Space Technology - OAST (Code R) - 12%**
  - **Office of Space Flight - OSF (Code M) - 8%\***
  - **Office of Space Systems Development - OSSD (Code D) - 8%\***

\* Shared between OSF and OSSD



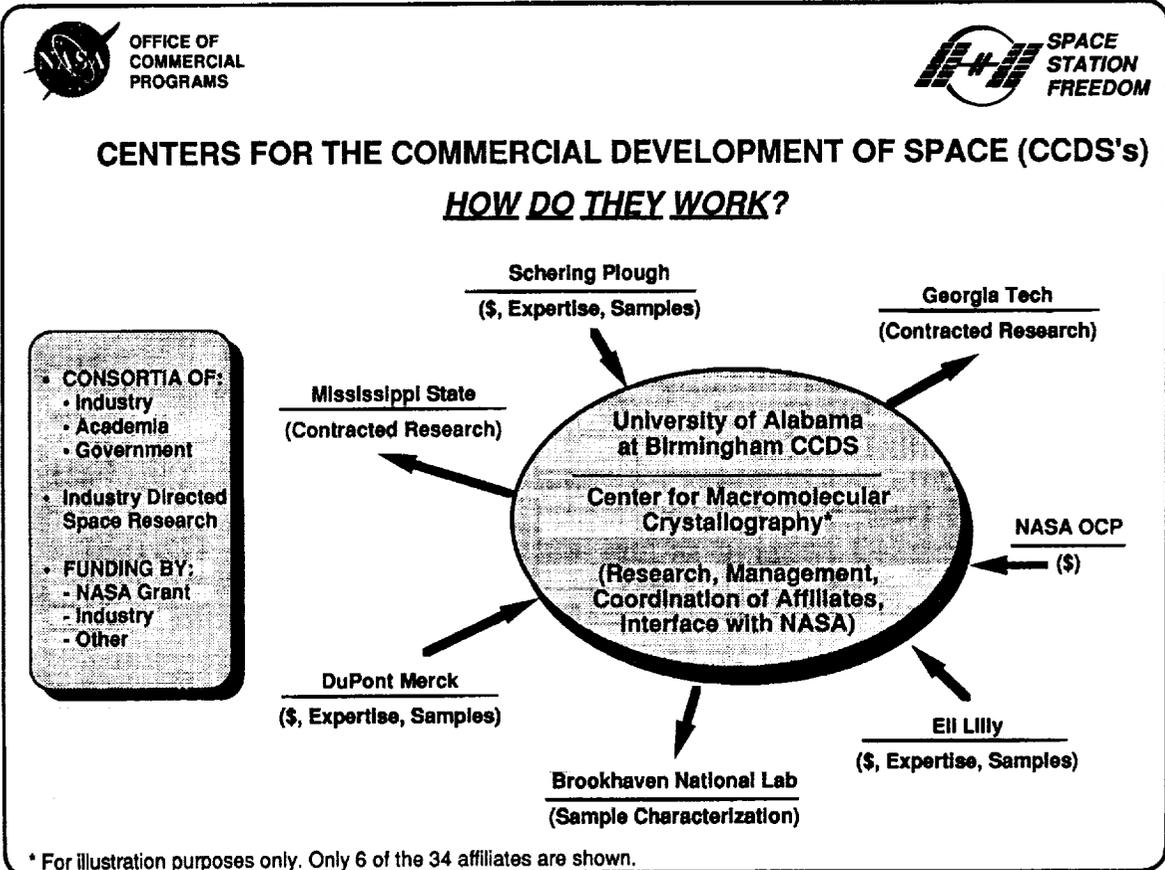
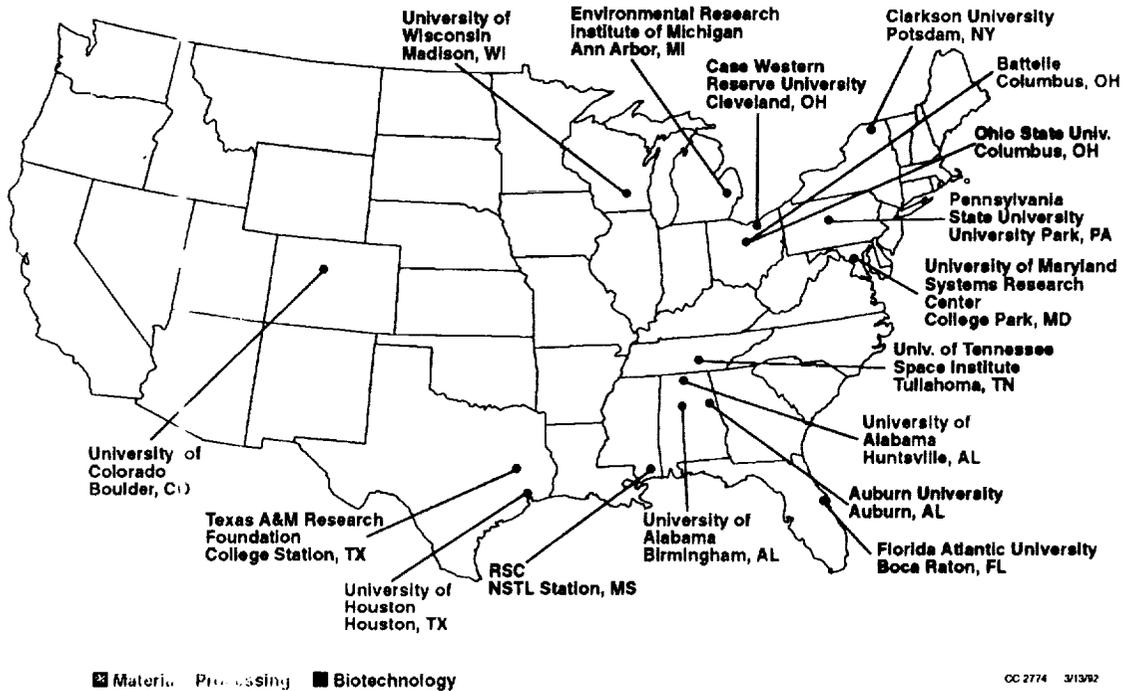
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**SPACE  
STATION  
FREEDOM**

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# Centers for Commercial Development of Space (CCDS)



**Auburn**

Solar Furnace Satellite  
Crystal Growth of Electronic Materials  
Computational Modeling of Casting Processes

**Battelle**

Solution Crystal Growth  
Polymer Composites  
Float Zone Crystal Growth - CdTe  
Zeolite Crystal Growth  
Doped Non-Linear Optic Substrates  
Investigations Into Polymer Membranes

**Bioserve**

Plant Growth Apparatus  
Blood Rheology Experiment  
Generic Bioprocessing Module  
Autonomous Biomedical Test Apparatus

**Case Western**

Materials Exposure - Basic, Advanced, & Applied

**Clarkson**

Zeolite Crystal Growth  
Low-Temp Solidification  
Liquid Encapsulated Melt Zone  
Directional Solidification - CdTe  
Chemical Vapor Transport - CdTe  
Commercial Solution Growth Facility

**CSTAR**

Cryogenic Fluid Management  
Electric, Chemical Propulsion  
Industrial Laser System Applications

**Florida Atlantic**

Transmission Techniques

**Ohio State**

Remote Sensing & Mapping

**Penn State**

Blomodule  
Telemedicine  
Bioseparations  
Bone Densitometry  
Physiological Systems Experiment  
Light Stimulator & Photon Detector  
Commercial Electrophoresis System

**SpARC**

Autonomous Rendezvous & Docking  
Automated Microgravity Materials Processing

**SRSC**

Remote Sensing & Applications

**SVEC**

Chemical, Molecular Beam Epitaxy Growth

**Texas A&M**

Micro Heat Pipe Evaluation  
Frozen Startup of Heat Pipe  
Microwave Power Transmission

**University of Alabama-Birmingham**

Protein Crystal Growth

**University of Alabama-Huntsville**

Polymer Foam  
Atomic Oxygen  
Electrodeposition  
3-D Accelerometer  
Immiscible Polymers  
Nuclear Track Detectors  
Space Experiment Facility  
Non-Linear Optical Materials  
Sintered & Alloyed Materials  
High-Temp Superconductors  
Materials Dispersion Apparatus

**University of Maryland**

Hybrid Networks

**WCSAR**

Astroculture™  
Bioregenerative Water System

CC-2929 2/6/92



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## THE CENTERS FOR THE COMMERCIAL DEVELOPMENT OF SPACE (CCDS)

### A MAJOR OBJECTIVE:

*To produce a body of knowledge and experience  
that will allow U.S. industrial entities to make  
informed decisions regarding their participation  
in commercial space endeavors*



## COMPARISON OF COMMERCIAL OPTIONS

**A Private Entity May Ask:**

***What options do I have to participate in a commercial space endeavor, and what are the relative comparisons of:***

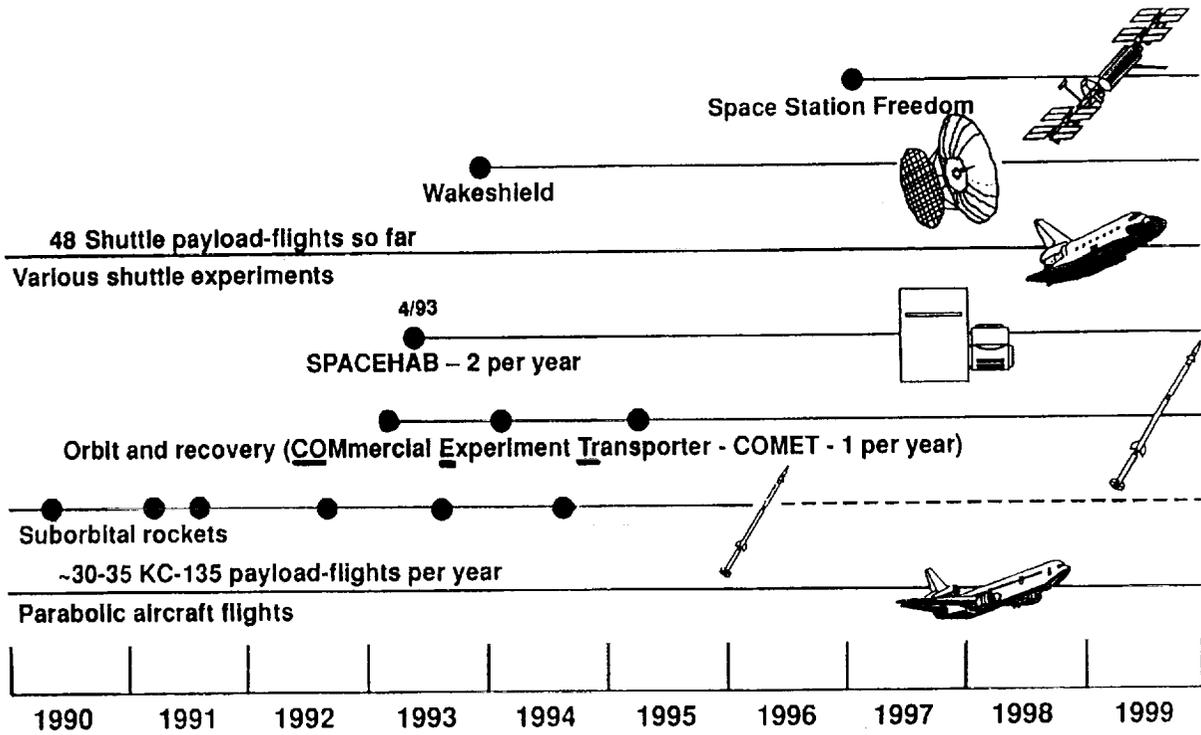
- 1. Risk to my investment?**
- 2. Cost of participating?**
- 3. Retention of Intellectual Property?**

	Join a CCDS	Negotiate a Joint Endeavor Agreement	Negotiate A Commercial Reimbursable Agreement
1. Risk	lower	←	→ higher
2. Cost	lower	←	→ higher
3. Intel. Prop.	keep some	←	→ keep all

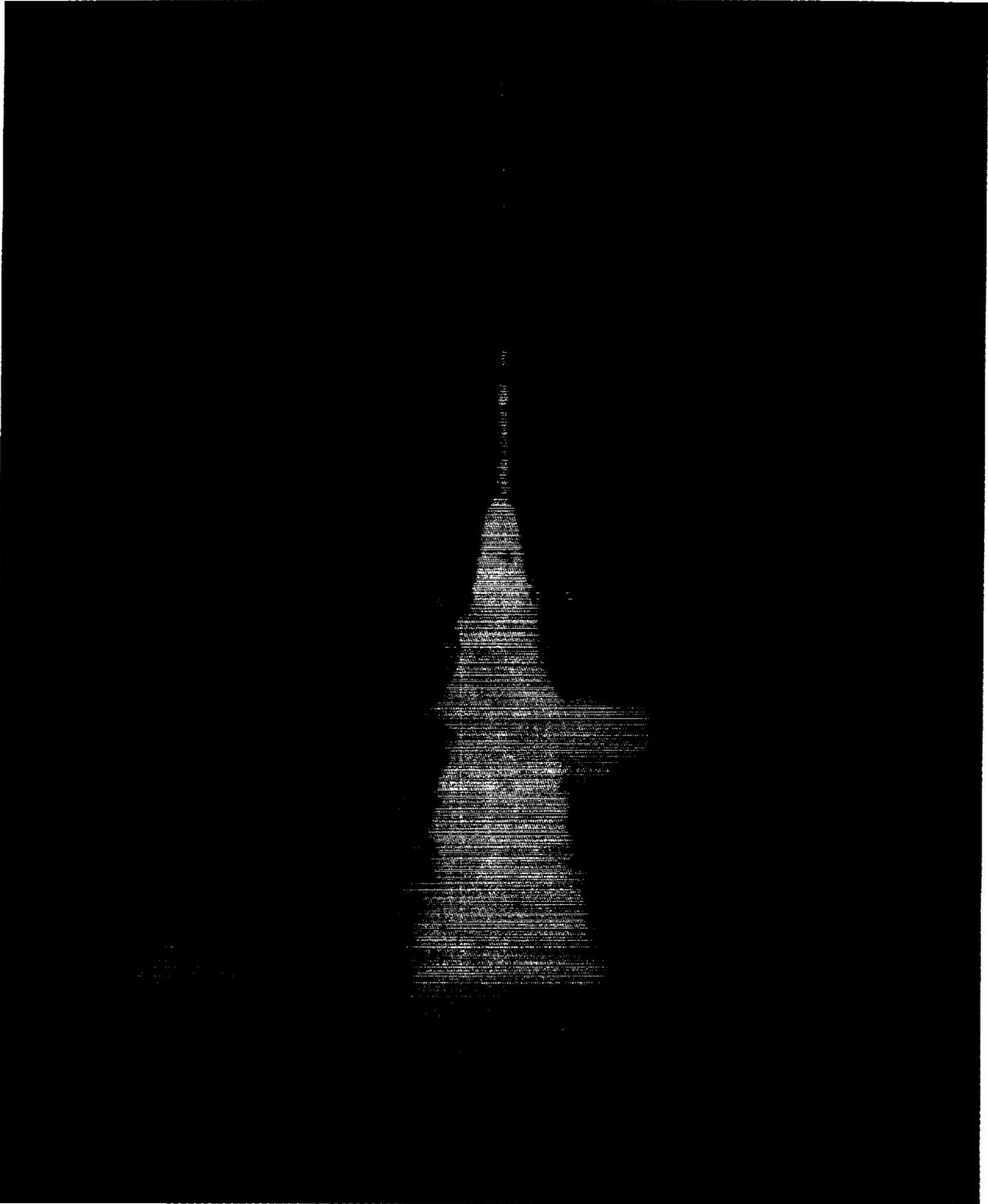


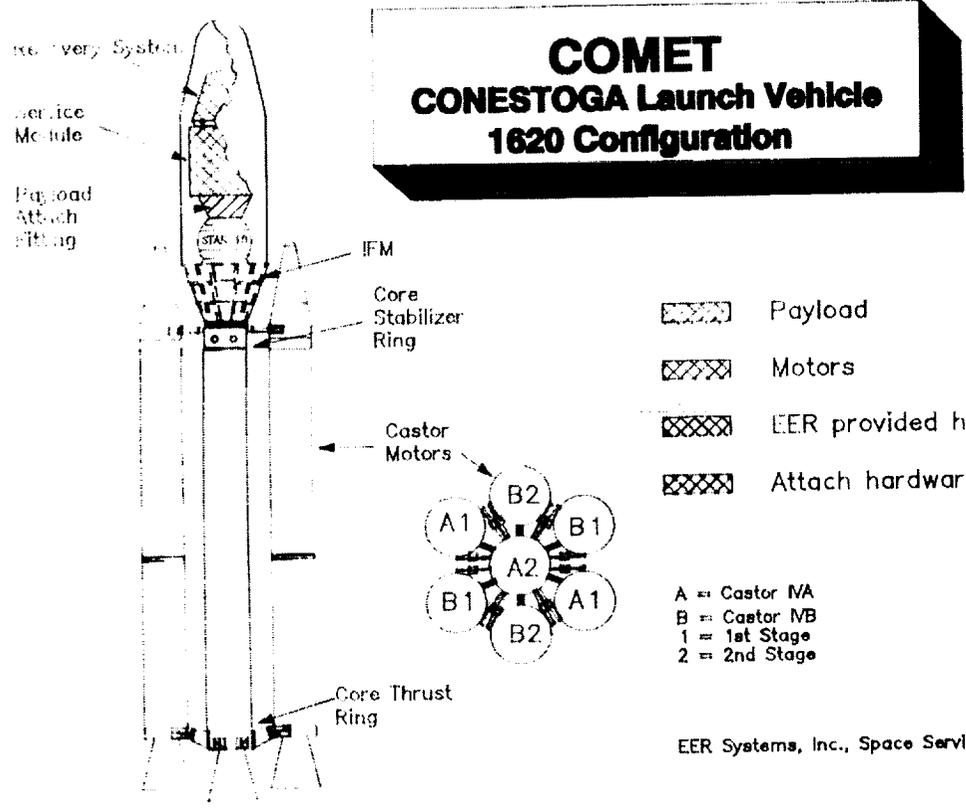
**HOW DO WE GET OUR EXPERIMENTS TO SPACE?**

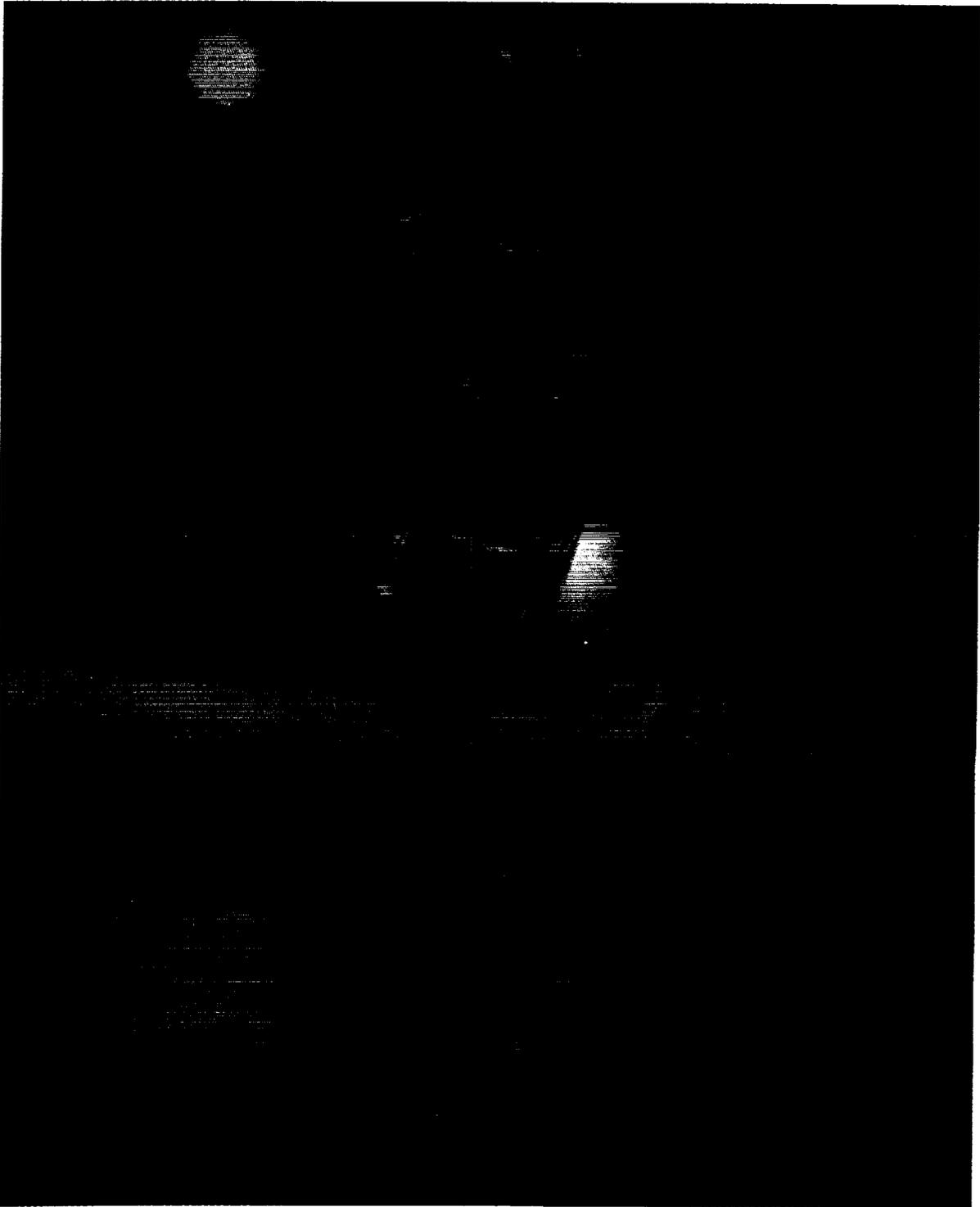
# Commercial Payload Evolution to Space Station



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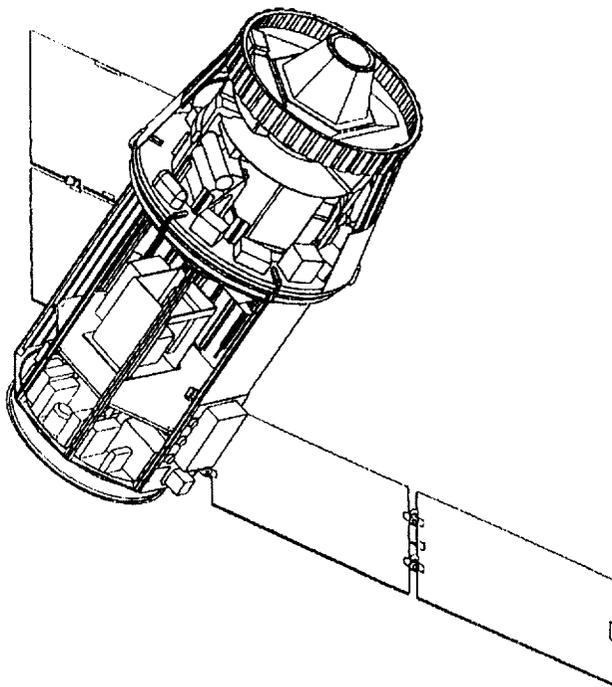
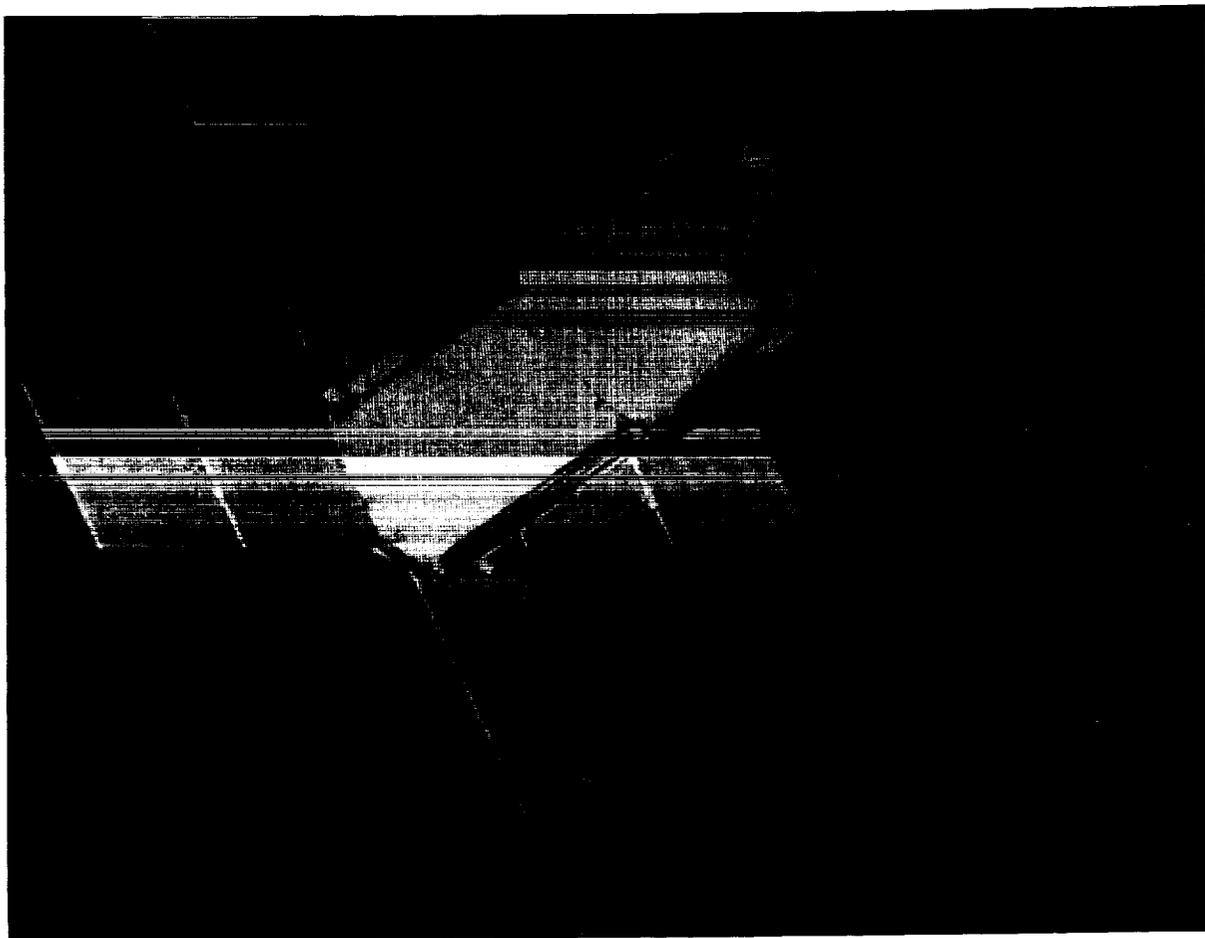
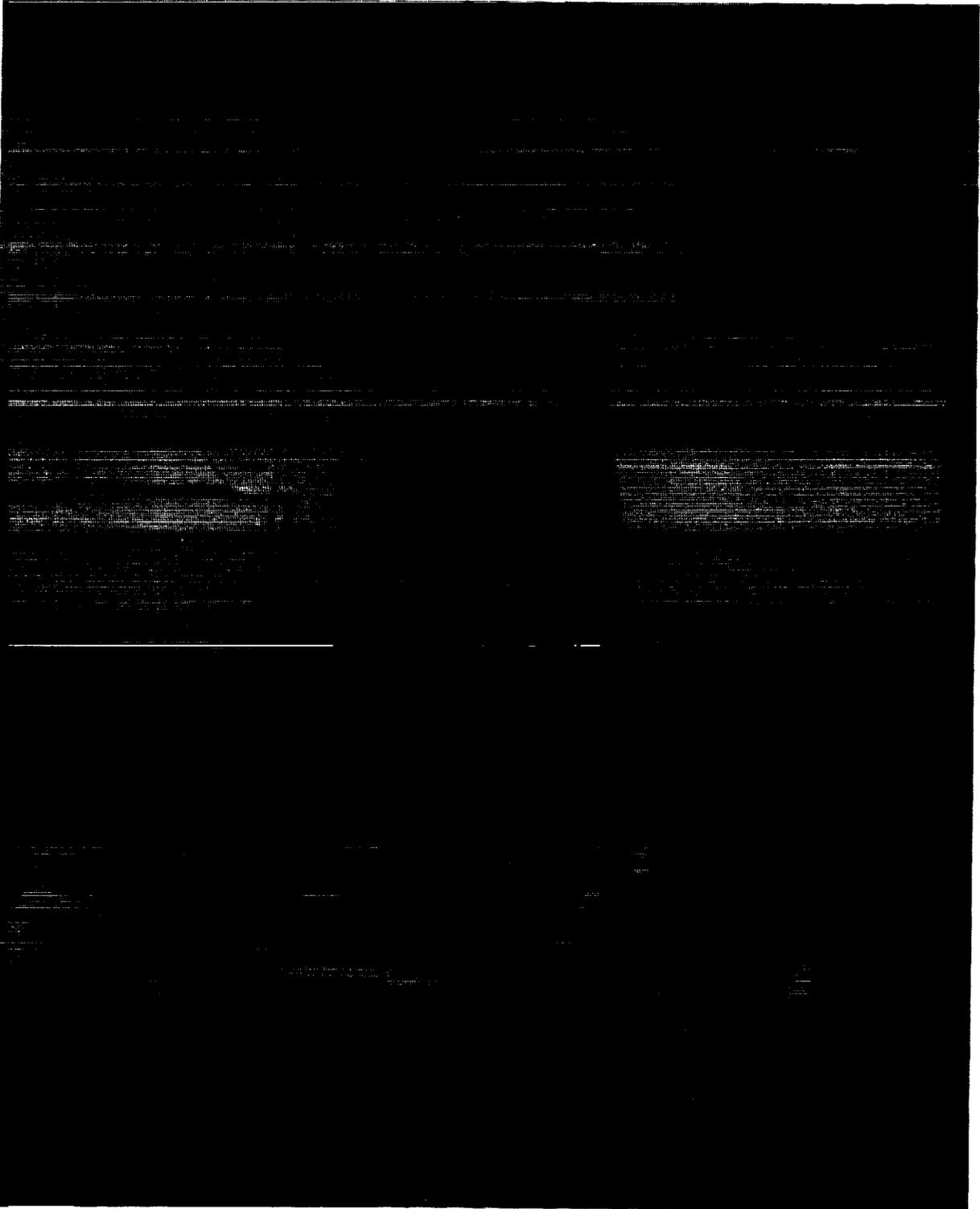
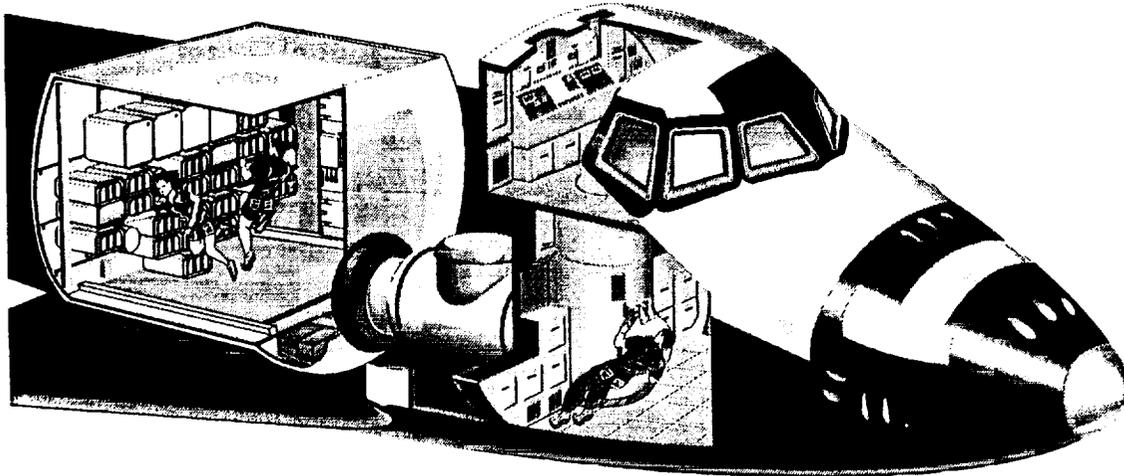


Figure 1.4-2 Cutaway View of COMET FreeFlyer





# SPACEHAB Module



## Payload Resources

### CONFIGURATIONS

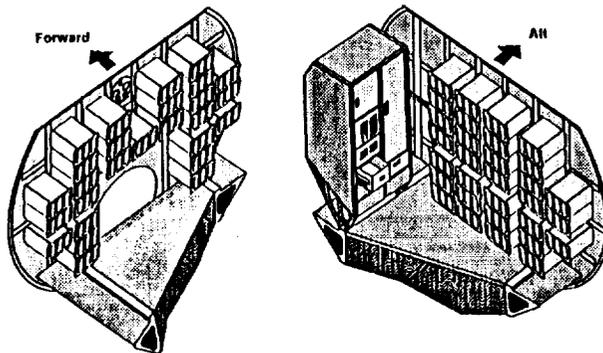
#### All Locker Configuration

71 lockers (max)

#### Rack & Locker Configurations

1 rack / 61 lockers (max)

2 racks / 51 lockers (max)



Mission planning will assess the compatibility of payloads in order to maximize the resources provided to each.

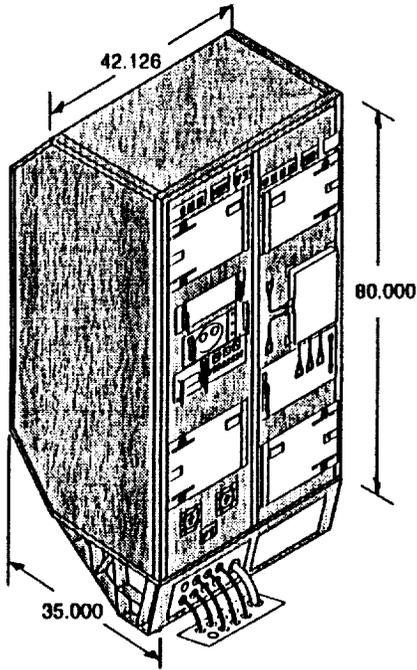
### TOTAL PAYLOAD RESOURCES

<b>Mass:</b>	English 3000 lb	Metric 1360 kg
<b>Volume:</b>	1100 ft <sup>3</sup>	31.1 m <sup>3</sup>
<b>Power*:</b>		
DC:	1750 - 3500 W	
Asc/Des	300 - 625 W	
AC:	690 VA	
<b>Cooling:</b>		
Air:	2000 W	
Water**:	4000 W	
<b>Crew:</b>	2	
<b>Other:</b>	<ul style="list-style-type: none"> <li>• Command/data subsystems</li> <li>• Fire detection/suppression</li> <li>• Vacuum venting</li> </ul>	

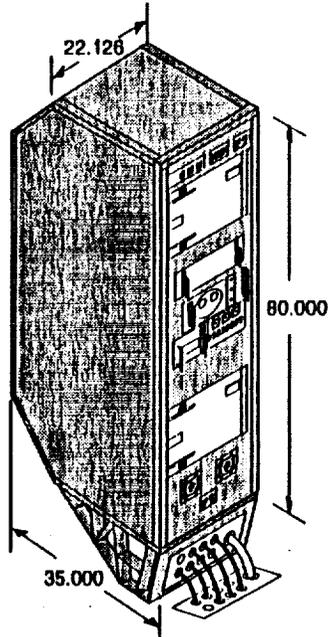
\* With 2 Orbiter Feeders, DC = 3150 W

\*\* Maximum water cooling level includes 2 kW plus whatever air capability is not used. (The orbiter can provide up to 6 kW cooling total on a special case basis.)

# Spacehab Racks



**Double Rack**  
(45 cu. ft., 1209 lb Experiment)



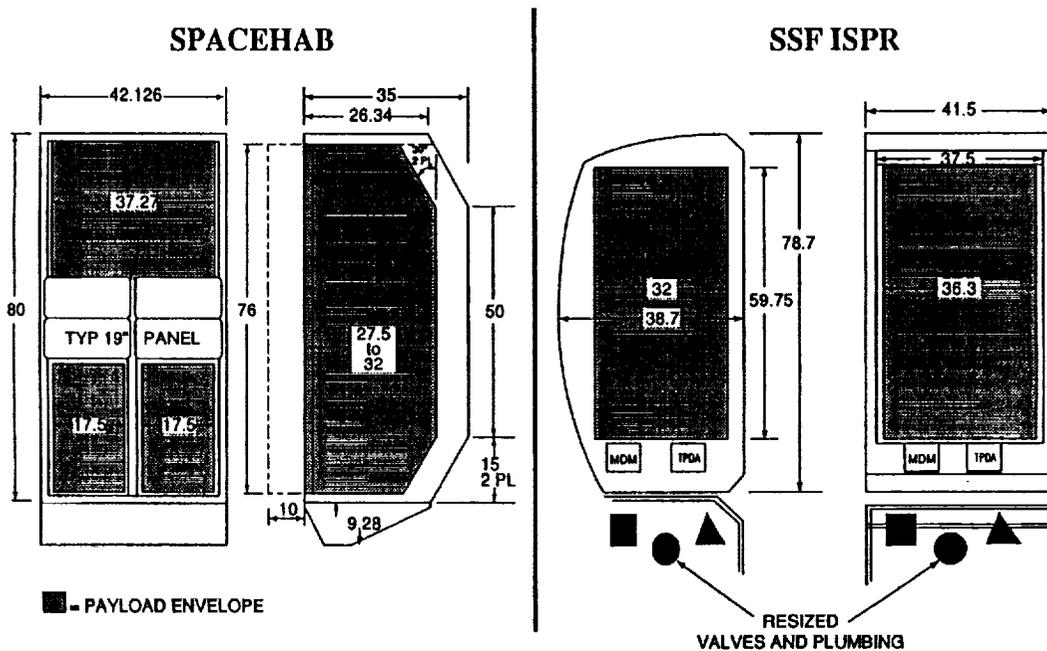
**Single Rack**  
(22.5 cu. ft., 855 lb Experiment)

**SPACEHAB**

**MODONNELL DOUGLAS**

## TRANSITION OF SPACEHAB PAYLOADS TO SSF

### RACK PAYLOAD ENVELOPES



## TRANSITION OF SPACEHAB PAYLOADS TO SSF

### RACK COMPARISON SUMMARY

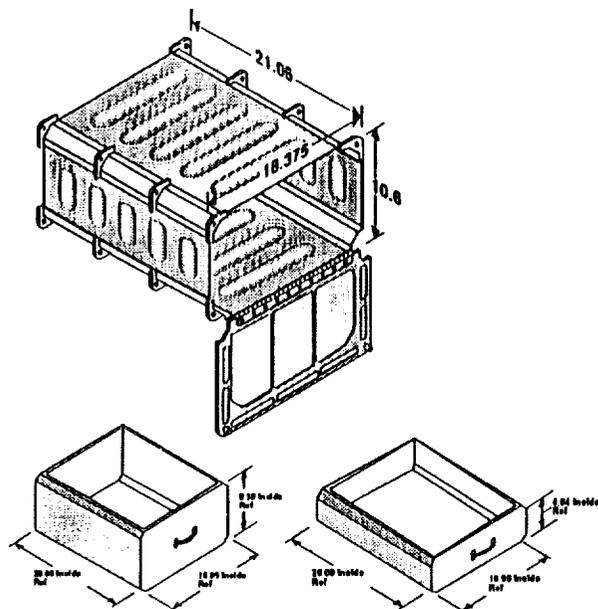
SPACEHAB		SPACE STATION FREEDOM
80 in. (2032 mm) High 42.126 in. (1070 mm) Wide 35 in. (889 mm) Deep 9.28 in. (235.71 mm) Base	<b>EXTERNAL RACK ENVELOPE</b>	78.7 in. (1999 mm) High 41.5 in. (1054.1 mm) Wide 38.7 in. (983 mm) Deep No Base
57 cu. ft. (1.61 cu. m) Inside Envelope  45 cu. ft. (1.27 cu. m) Design Volume	<b>RACK PAYLOAD VOLUME</b>	55 cu. ft. (1.55 cu. m) Inside Envelope  40 cu. ft. (1.13 cu. m) Max Rectangular Volume
19.9 sq. ft. (1.85sq. m) Single Bay  18.7 sq. ft. (1.74 sq. m) Double Bay	<b>FRONT OPENING FOR PAYLOADS</b>	15.8 sq. ft. (1.47 sq. m) Single Bay  15.0 sq. ft. (1.39 sq. m) Double Bay
EIA-RS-310-C	<b>FRONT PANEL MOUNTING STANDARD</b>	EIA-RS-310-C
17.73 in. (450.34 mm) Single Bay  37.73 in. (958.34 mm) Double Bay	<b>FRONT FLANGE OPENING</b>	17.75 in. (450.85 mm) Single Bay  37.5 in. (952.5 mm) Double Bay
1250 lbs. (567 kg)	<b>LOAD CARRYING CAPABILITY</b>	882lbs. (400 kg) Standard 1534 lbs. (700 kg) Optional

## TRANSITION OF SPACEHAB PAYLOADS TO SSF

### RACK COMPARISON SUMMARY

SPACEHAB		SPACE STATION FREEDOM
Rack Base, Front	<b>UTILITY INTERFACE PANEL</b>	Pass Through Panel inside Rack, Interface Panel on Rack Standoff
1 kw (average) 2 kw (peak) 28 Volts DC	<b>DC POWER</b>	3, 6, or 12 kw 120 Volts DC User provides power conversion
690 VA, 400 hz	<b>AC POWER</b>	None
2, 4, 8, 16 kbps (48 mbps optional) User provides Dedicated Experiment Processor	<b>COMMAND AND DATA</b>	16 mbps (48 mbps total) 1553 Data Bus Standard 802.4 FDDI Optional User purchases MDM User Provides Dedicated Experiment Processor if required
1 kw average per rack 2 kw total module	<b>RACK AIR COOLING</b>	1.2 kw max per rack 3.6 kw total module
1 kw	<b>PAYLOAD WATER LOOP CAPACITY</b>	8 kw
1.4 E-5 Torr to 1.0 E-6 Torr	<b>VACUUM</b>	10 E-3 Torr

# Locker Capacity



Mass:	English	Metric
Standard Accom	42 lbs	20.9 kg
Design Limit	60 lbs	27.2 kg
C.G.:	14 in*	35.6 cm
Volume:		
Entire Locker	2.0 ft <sup>3</sup>	0.057 m <sup>3</sup>
Small Tray	0.9 ft <sup>3</sup>	0.025 m <sup>3</sup>
Large Tray	1.9 ft <sup>3</sup>	0.054 m <sup>3</sup>

Data: Accommodated through manifesting of compatible payloads.

D.C. Power	
On Orbit:	115 W (Continuous) 180 W (Peak) for TBD Min @ 28 +/-4 VDC

Ascent/Descent\*\*

Cooling: Payload heat generation above 60W requires forced air cooling.

SPACEHAB had the capability of accommodating Middeck locker payloads without modification

**SPACEHAB**

**MCDONNELL DOUGLAS**

## Flight Schedule

Flight 1	April 1993
Flight 2	October 1993
Flight 3	April 1994
Flight 4	October 1994
Flight 5	March 1995
Flight 6	August 1995

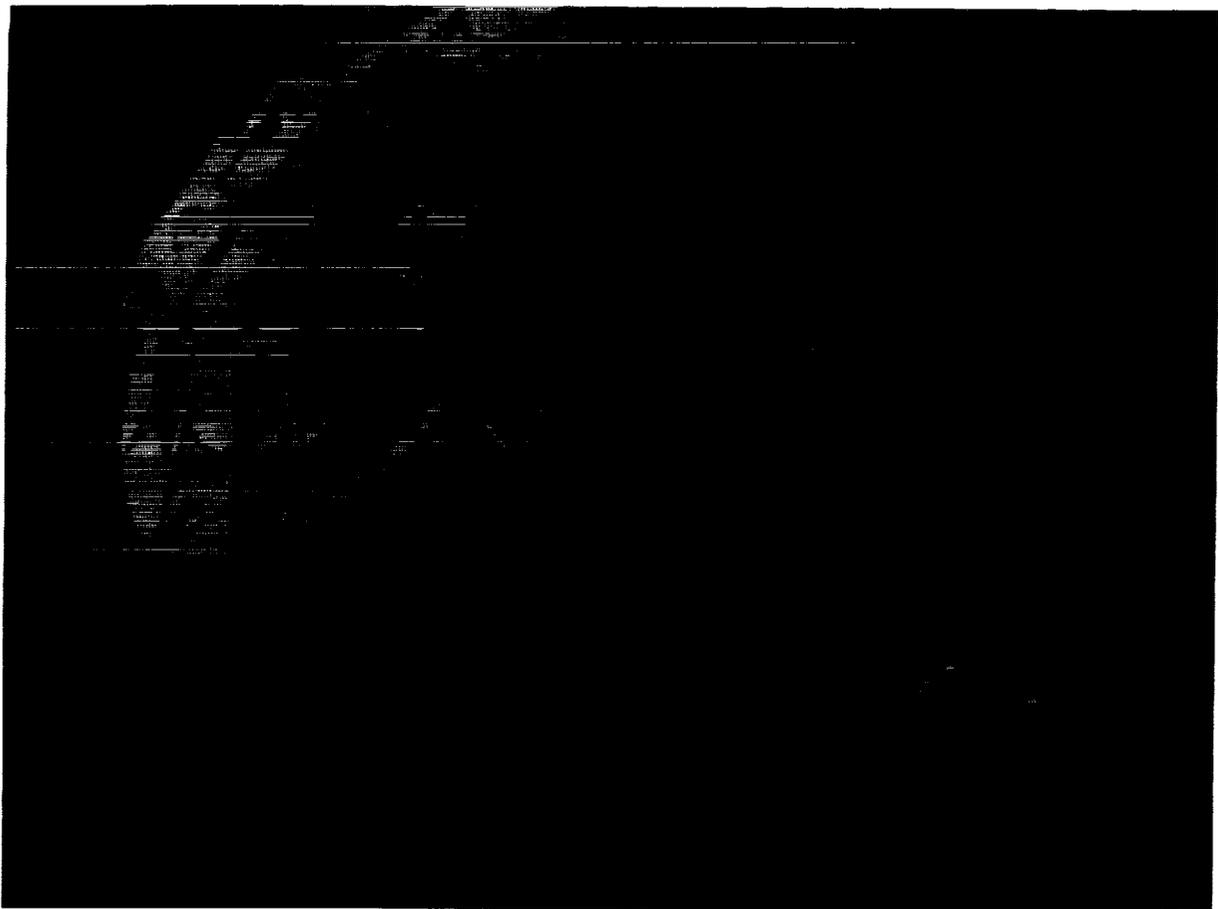
Subsequent Flights will be Scheduled to Satisfy Market Demands.

**SPACEHAB**

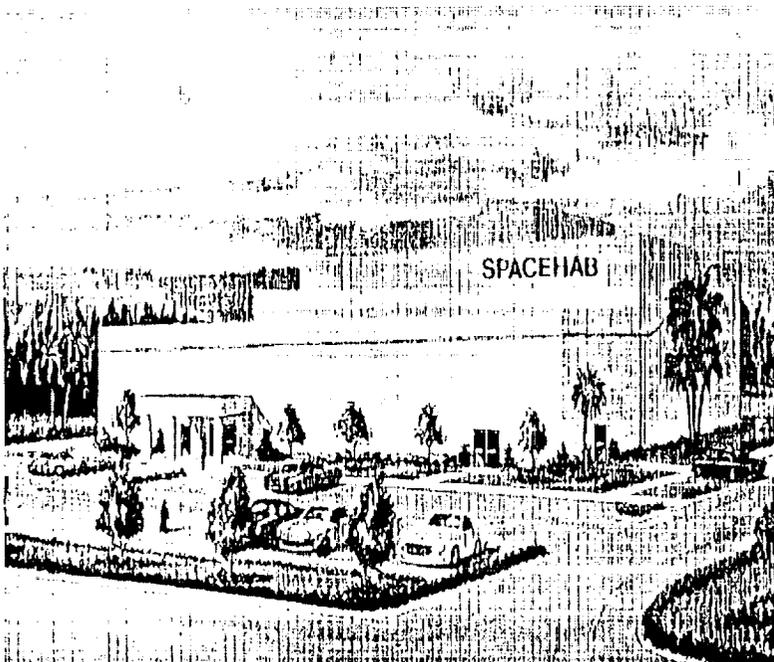
**MCDONNELL DOUGLAS**



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## SPACEHAB Payload Processing Facility (SPPF)



- 35,000 square feet of payload integration, test, training & support facilities
- 6,000 square feet of Customer Work Area (CWA), subdivided into industrial secure rooms
- Shipping / Receiving provided for receipt of hardware.
- Clean Room - 100K class conditions in shipping / receiving, CWAs, & integration hall
- General classrooms, conference rooms, copiers, and fax machine available for use on shared basis.
- Availability date: 3/1/91
- Located on commercial site near KSC.

## FLIGHTS OF U.S. COMMERCIAL PAYLOADS

PAYLOAD NAME	No. Of FLIGHTS	MISSION(S)
1 ASTROCULTURE	1	STS 50
2 AUTOMATED GENERIC BIOPROCESSING APPARATUS	2	Consort 3, 4
3 BIOMODULE	2	Consort 3, 4
4 BIOSERVE INSTRUMENTATION MATERIALS DISPERSION APP.	2	STS 37, 43
5 CONTINUOUS FLOW ELECTROPHORESIS (I, II, & III)	7	STS 4, 6, 7, 8, 12, 16, 23
6 DEMIXING OF IMMISCIBLE POLYMERS MIXER	2	Consort 1, 3
7 DIFFUSIVE MIXING OF ORGANIC SOLUTIONS	2	STS 14, 23
8 DIRECTED POLYMERIZATION APPARATUS (USML-1 GBX exper.)	1	STS 50
9 ELASTOMER-MODIFIED EPOXY RESINS HEATERS	2	Consort 1, 3
10 ELECTRODEPOSITION CELLS	4	Consort 1, 3, 4, STS 40 (GAS 105)
11 EQUIPMENT FOR CONTROLLED LIQUID PHASE SINTERING	1	Consort 4
12 FLUID EXPERIMENT APPARATUS	2	STS 30, 32
13 FOAM-FORMATION DEVICE	2	Consort 1, 3
14 GELATION OF SOLS: APPLIED MICROGRAVITY RESEARCH	1	STS 42
15 GENERIC BIOPROCESSING APPARATUS	1	STS 50
16 PROTEIN CRYSTAL GROWTH (Hand-Held, VDA, PCF, CRIM, GBX)	14*	STS 16, 19, 23, 24, 26, 29, 32, 31, 37, 43, 48, 42, 50
17 INVESTIGATIONS INTO POLYMER MEMBRANE PROCESSES	2	Consort 3, 4
18 INVESTIGATIONS INTO POLYMER MEMBRANE PROCESSING	7	STS 31, 41, 43, 48, 42, 45, 50
19 MATERIALS DISPERSION APPARATUS	3	Consort 1, 3, 4
20 METAL SINTERING FURNACE	1	Consort 1
21 NON-LINEAR OPTICAL CRYSTAL GROWTH (DAN) - UAH/IBM	1	STS 40 (GAS 105)
22 NON-LINEAR OPTICAL CRYSTAL GROWTH (NCA) - UAH/TBE	1	STS 40 (GAS 105)
23 PHYSICAL VAPOR TRANSPORT OF ORGANIC SOLIDS	2	STS 20, 26
24 PHYSIOLOGICAL SYSTEMS EXPERIMENTS	1	STS 41
25 PLASMA PARTICLE GENERATION	1	Consort 3
26 POLYMER CURING EXPERIMENT	1	Consort 4
27 POLYMER MORPHOLOGY	1	STS 34
28 POLYMER THIN FILMS	2	Consort 3, STS 40 (GAS 105)
29 SEPARATION OF AQUEOUS PHASES	1	STS 40 (GAS 105)
30 SPACE FORMED STRUCTURAL BEAM (Foam Formation Device)	1	Consort 4
31 YEAST EXPERIMENT	1	STS 40 (GAS-105)
32 ZEOLITE CRYSTAL GROWTH	1	STS 50
<b>32 TOTAL PAYLOAD HARDWARE ITEMS</b>	<b>73 TOTAL NUMBER OF PAYLOAD FLIGHTS**</b>	

16-Jul-92

- \* The Protein Crystal Growth experiments were shared between the OCP and OSSA  
 \*\* A payload-flight = one flight of one payload. Therefore, one flight with 3 payloads = 3 payload-flights

*Shuttle - 48*  
*Consort - 25*  


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*73*



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### SSF RESOURCE ALLOCATIONS



	NASA U.S.A.	MOSST Canada	ESA Europe	STA Japan
Utilization Resources	71.4%	3%	12.8%	12.8%

**OSSA - Science: 65%\***

**OCP - Commercial: 35%\***

**OAST - Technology: 15%\***

**OSF/OSSD - Other: 10%\***

**1997 OCP SSF Resources**

Pressurized Up Mass: 4,352 kg

Pressurized Down Mass: 3,784 kg

Unpressurized Up Mass: 4,209 kg

Unpressurized Down Mass: 7,073

Volume Up: 9.5 DRE

Volume Down: 7.1 DRE

Power: 3 kW

Downlink: 10,472 kb/s

Crew Time: 436 hours

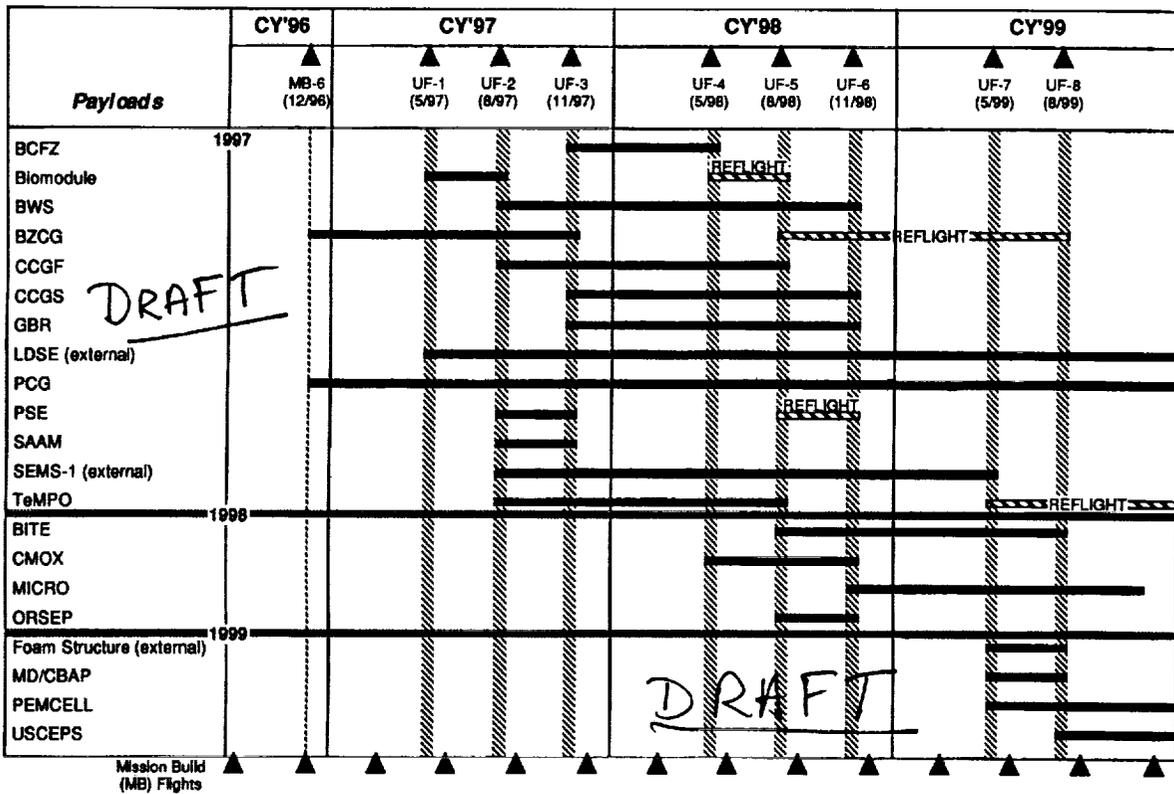
Data Storage: 92 Mbytes

Racks Occupied On-Orbit: 5 DRE

Truss Attach Points: 0.7 APs

\* Utilization planning guidelines allow the total resources used by NASA's User Sponsors to equal 125%, for the launch minus 5 year timeframe.

# DRAFT OCP FLIGHT MANIFEST FOR SSF



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The Office of Commercial Programs is Producing

- *A body of applications-oriented scientific knowledge*
- *An experience base in payload flight hardware development and integration*
- *A complement of payload hardware*
- *Transportation systems and carriers*

that will allow us to transition to Space Station Freedom